

PATENT ABSTRACTS OF JAPAN



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(21)Application number : 07-074729 (71)Applicant : CANON INC

(22)Date of filing : 08.03.1995 (72)Inventor : HASHIMOTO SHIGERU
TERADA JUNJI

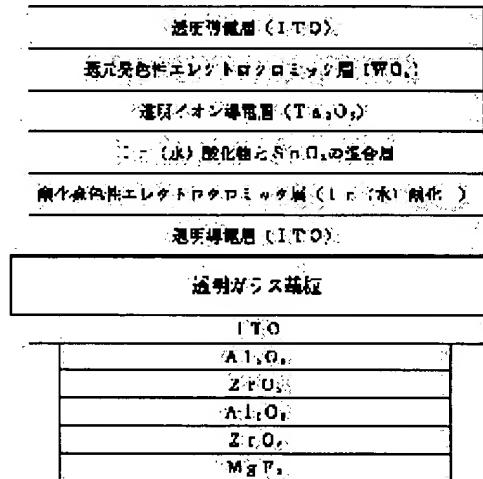
(54) ELECTROCHROMIC ELEMENT

(57)Abstract:

PURPOSE: To improve coloring characteristics of an electrochromic element

(coloring rate and contrast ratio of coloring and decolor) in a low temp. environment.

CONSTITUTION: This element has such a structure that an electrochromic functional layer including a reductive color developing electrochromic layer and a transparent ion conductive layer, and an antireflection layer including a transparent heat generating layer of ITO are held between a pair of transparent conductive layers and that these layers are held between transparent glass substrates.



LEGAL STATUS

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CLAIMS

[Claim(s)]

[Claim 1] The electrochromic element characterized by having the configuration in which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least, and the heating element layer were formed on both sides of the substrate between the electrode layers of a couple.

[Claim 2] The electrochromic element characterized by ****ing the aforementioned electrochromic stratum functionale and the aforementioned heating element layer inside for substrate A by which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least was formed between the electrode layers of a couple, and substrate B in which the heating element layer was formed, or carrying out the aforementioned electrochromic stratum functionale inside, carrying out the aforementioned heating element layer outside, and having the configuration which carried out opposite arrangement.

[Claim 3] The electrochromic element characterized by having the configuration in which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least, and the transparent heating element layer were formed on both sides of the transparent substrate between the transparent-electrode layers of a couple.

[Claim 4] The electrochromic element according to claim 3 characterized by forming the acid-resisting layer further on the aforementioned transparent heating element layer.

[Claim 5] The electrochromic element characterized by ****ing the aforementioned electrochromic stratum functionale and the aforementioned transparent heating element layer inside for transparent substrate A by which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least was formed between the transparent-electrode layers of a couple, and transparent substrate B in which the transparent heating element layer was formed, or carrying out the aforementioned electrochromic stratum functionale inside, carrying out the aforementioned transparent heating element layer outside, and having the configuration which carried out opposite arrangement.

[Claim 6] The electrochromic element according to claim 5 characterized by forming the acid-resisting layer in the field of the outside of the aforementioned transparent substrate A, and the field of the outside of the aforementioned transparent substrate B.

[Claim 7] The electrochromic element according to claim 3 to 6 with which the aforementioned transparent-electrode layer is characterized by ITO (SnO₂ inclusion In₂O₃) and the aforementioned reduction coloring nature electrochromic layer being [WO₃ and the aforementioned transparent heating element layer] ITOs the sheet resistance of 10ohms / more than **.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention relates to the electrochromic element applied as a display device or a permeability adjustable VCF.

[0002]

[Description of the Prior Art] Since there is the characteristic feature that memory nature which is not influenced [with the high permeability at the time of decolorization] of polarization is, as compared with a liquid crystal device etc., the electrochromic (it is hereafter described as "EC") element worn and decolorized by impressing a voltage is studied about the application to a display device, a permeability adjustable VCF, etc.

[0003] As one of them, it is WO₃ to a reduction coloring nature electrochromic layer. Used EC element is proposed in JP,52-46098,B.

[0004] This WO₃ H⁺ which water decomposed in the electric field in order to have colored A cation is required and it is at the time of tinction. WO₃+(-less coloring) ne-+nH⁺->H_n WO₃ (tinction)

nH₂O->nH⁺⁺nOH - The reaction to say is presumed.

[0005]

[Problem(s) to be Solved by the Invention] However, it is WO₃ as mentioned above. Since water was indispensable to tinction, when EC element was used at the freezing point like a skiing area, there was a trouble where did not color or a tinction speed became slow.

[0006] Moreover, as an improvement of the tinction speed in the low-temperature environment of EC element, although proposed by JP,61-59317,A, since the same electric conduction layer was performing tinction and generation of heat, this had the trouble where a circuit did not become complicated or a voltage could not be made high only for generation of heat.

[0007] Therefore, the purpose of this invention is to improve the tinction property (tinction speed, wearing contrast ratio of decolorization) in the low-temperature environment of EC element with easy structure.

[0008]

[Means for Solving the Problem and its Function] The configuration of this invention for attaining the above-mentioned purpose is as follows.

[0009] That is, it is in the electrochromic element characterized by having the configuration in which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least, and the heating element layer were formed on both sides of the substrate between the electrode layers of a couple the first of this invention.

[0010] It is in the electrochromic element characterized by ****ing the aforementioned electrochromic stratum functionale and the aforementioned heating element layer inside for substrate B by which the heating element layer was formed between the electrode layers of the second couple of this invention with substrate A in which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least was formed, or carrying out the aforementioned electrochromic stratum functionale inside, carrying out the aforementioned heating element layer outside, and having the configuration which carried out opposite arrangement.

[0011] It is in the electrochromic element characterized by having the configuration by which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least, and the transparent heating element layer were formed on both sides of the transparent substrate between the transparent-electrode layers of the third couple of this invention.

[0012] It is to the electrochromic element characterized by to **** the aforementioned electrochromic stratum functionale and the aforementioned transparent heating element layer inside for transparent substrate B by which the transparent heating element layer was formed between the transparent-electrode layers of the fourth couple of this invention with transparent substrate A in which the electrochromic stratum functionale which has a reduction coloring nature electrochromic layer and a transparent ion electric conduction layer at least was formed, or to carry out the aforementioned electrochromic stratum functionale inside, to carry out the aforementioned transparent heating element layer outside, and to have the configuration which carried out opposite arrangement.

[0013] By making this generate heat by impressing a voltage to a heating element layer, the electrochromic element of this invention shows a good tinction property, when using it in an environment below the freezing point.

[0014] As for the third of the aforementioned this invention, and the fourth, it is desirable that start a penetrated type electrochromic element and the acid-resisting layer is especially formed further on the aforementioned transparent heating element layer by this invention third, and it is desirable that the acid-resisting layer is formed in the field of the outside of the aforementioned transparent substrate A and the field of the outside of the aforementioned transparent substrate B in this invention fourth. Thereby, the optical property of a penetrated type electrochromic element can be improved.

[0015] As a transparent-electrode layer concerning the third of this invention, and the fourth, they are ITO(SnO₂ inclusion In₂O₃), In₂O₃, and SnO₂, for example. Although a grade can be used, ITO (weight ratio In₂O₃ / SnO₂ ** 95/5) is desirable in respect of an optical property or resistance.

[0016] As a reduction coloring nature electrochromic layer, they are WO₃, MoO₃, Nb₂O₅, and TiO₂, for example. Although a grade can be used, it is WO₃ in the field of a tinction speed. It is desirable.

[0017] As a transparent heating element layer, ITO can be used, for example and, as for the sheet resistance, it is desirable that they are more than 10ohms / **. It is easy to produce the problem that the sheet resistance of a transparent heating element layer does not generate

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heat enough with the parvus rather than 10ohms / **, or power consumption becomes large.

[0018] As a method of forming above-mentioned each class, the well-known forming [membranes] method can be used, for example, vacuum deposition, a spatter, an ion plating, CVD, etc. are used. Moreover, the thickness of each class has 1 to desirable 5000nm, and it is suitably designed by an optical property, repeat endurance, etc. which are demanded.

[0019]

[Example] An example is shown below and this invention is explained to it in detail.

[0020] It is the typical block diagram of a substrate and while [example 1] view 1 constitutes the electrochromic element of this example explains the manufacture process below.

[0021] First, the transparent heating element layer and the acid-resisting layer were formed on the transparent glass substrate. Specifically They are ITO transparency heating element layer:1.9 and aluminum2 O3 from a substrate side about refractive-index:1.70 of the transparent glass substrate to light with a main wavelength of 540nm, and the refractive index of each class. : 1.6, ZrO2 : 2.1, aluminum2 O3 : 1.6, ZrO2 : 2.1 and MgF2 : Each optical thickness was formed with vacuum deposition by 1.38 as 90nm, 20nm, 159nm, 23nm, 66nm, and 135nm.

[0022] Next, the field in which the above-mentioned transparent heating element layer and acid-resisting layer of a transparent glass substrate were formed is substrate temperature =300 degree C and O2 as a layer [1st] transparent-electrode layer (transparent electric conduction layer) on the field of an opposite side. On condition that partial pressure =5x10-2Pa, ITO was formed by the 150nm thickness by the vacuum deposition method.

[0023] Next, it is a substrate temperature = room temperature and O2 as an oxidization coloring nature electrochromic layer of the 2nd layer. Ir oxide was formed by the 5nm thickness by the RF spatter which used the metal Ir as the target on partial pressure =1Pa conditions.

[0024] Next, it is Ir(water) oxide and SnO2 by the 2 yuan RF spatter using the metal Ir target and the metal Sn target as a mixolimnion of the 3rd layer at a substrate temperature = room temperature and steam partial pressure =1Pa conditions. The mixolimnion was formed by the 25nm thickness.

[0025] Next, it is substrate temperature =300 degree C and O2 as a layer [4th] transparent ion electric conduction layer. At the conditions of partial pressure =3x10-2Pa, it is Ta2 O5 by the vacuum deposition method. It formed by the 300nm thickness.

[0026] Next, it is substrate temperature =300 degree C and O2 as a reduction coloring nature electrochromic layer of the 5th layer. At the conditions of partial pressure =5x10-2Pa, it is WO3 by the vacuum deposition method. It formed by the 1000nm thickness.

[0027] Next, as a layer [6th] transparent-electrode layer (transparent electric conduction layer), on condition that substrate temperature =300 degree C, O2 partial-pressure =5x10-2Pa, and RF power =150W, ITO was formed by the 300nm thickness by the RF ion-plating method, and the electrochromic stratum functionale of six layer structures was formed.

[0028] The resin seal of the field by the side of pure of the transparent glass substrate which formed the acid-resisting layer in one side separately the electrochromic stratum-functionale side of the substrate of the drawing 1 obtained as mentioned above was carried out and carried out inside, and the electrochromic element was constituted.

[0029] When the tinction speed from which the current of 0.5A is supplied to the transparent heating element layer of this electrochromic element on the voltage of direct-current 5V, the voltage of **2V is impressed between both the transparent electric conduction layers of the electrochromic stratum functionale, and the contrast ratio of mean permeability with a wavelength of 400-700nm becomes ten or more was measured in the 40 degrees C - -20 degrees C environment, it was 20 or less msec in any environment.

[0030] First, the acid-resisting layer was formed on [example 2] transparent glass-substrate A.

[0031] Next, the field in which the acid-resisting layer was formed is substrate temperature =300 degree C and O2 as a layer [1st] transparent-electrode layer (transparent electric conduction layer) on the field of an opposite side. On condition that partial pressure =5x10-2Pa, ITO was formed by the 150nm thickness by the vacuum deposition method.

[0032] Next, it is a substrate temperature = room temperature and O2 as an oxidization coloring nature electrochromic layer of the 2nd layer. Ir oxide was formed by the 5nm thickness by the RF spatter which used the metal Ir as the target on partial pressure =1Pa conditions.

[0033] Next, it is Ir(water) oxide and SnO2 by the 2 yuan RF spatter using the metal Ir target and the metal Sn target as a mixolimnion of the 3rd layer at a substrate temperature = room temperature and steam partial pressure =1Pa conditions. The mixolimnion was formed by the 25nm thickness.

[0034] Next, it is substrate temperature =300 degree C and O2 as a layer [4th] transparent ion electric conduction layer. At the conditions of partial pressure =3x10-2Pa, it is Ta2 O5 by the vacuum deposition method. It formed by the 300nm thickness.

[0035] Next, it is substrate temperature =300 degree C and O2 as a reduction coloring nature electrochromic layer of the 5th layer. At the conditions of partial pressure =5x10-2Pa, it is WO3 by the vacuum deposition method. It formed by the 1000nm thickness.

[0036] Next, as a layer [6th] transparent-electrode layer (transparent electric conduction layer), on condition that substrate temperature =300 degree C, O2 partial-pressure =5x10-2Pa, and RF power =150W, ITO was formed by the 300nm thickness by the RF ion-plating method, and the electrochromic stratum functionale of six layer structures was formed.

[0037] The resin seal of the transparent heating element layer [layer / acid-resisting] side of transparent substrate B which formed in one side and formed the transparent heating element layer of ITO in the opposite side separately the electrochromic stratum-functionale side of substrate A obtained as mentioned above at it was carried out and carried out inside, and the electrochromic element was constituted.

[0038] When the tinction speed from which the current of 0.5A is supplied to ITO heating element layer by the side of transparent substrate B of this electrochromic element on the voltage of direct-current 5V, the voltage of **2V is impressed between both the transparent electric conduction layers of the electrochromic stratum functionale by the side of substrate A, and the contrast ratio of mean permeability with a wavelength of 400-700nm becomes ten or more was measured in the 40 degrees C - -20 degrees C environment, it was 20 or less msec in any environment.

[0039] First, the acid-resisting layer was formed on [example 3] transparent glass-substrate A.

[0040] Next, the field in which the acid-resisting layer was formed is substrate temperature =300 degree C and O2 as a layer [1st] transparent-electrode layer (transparent electric conduction layer) on the field of an opposite side. On condition that partial pressure =5x10-2Pa, ITO was formed by the 150nm thickness by the vacuum deposition method.

[0041] Next, it is a substrate temperature = room temperature and O2 as an oxidization coloring nature electrochromic layer of the 2nd layer. Ir oxide was formed by the 5nm thickness by the RF spatter which used the metal Ir as the target on partial pressure =1Pa conditions.

[0042] Next, it is Ir(water) oxide and SnO2 by the 2 yuan RF spatter using the metal Ir target and the metal Sn target as a mixolimnion of

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the 3rd layer at a substrate temperature = room temperature and steam partial pressure =1Pa conditions. The mixolimnion was formed by the 25nm thickness.

[0043] Next, it is substrate temperature =300 degree C and O2 as a layer [4th] transparent ion electric conduction layer. At the conditions of partial pressure =3x10-2Pa, it is Ta2 O5 by the vacuum deposition method. It formed by the 300nm thickness.

[0044] Next, it is substrate temperature =300 degree C and O2 as a reduction coloring nature electrochromic layer of the 5th layer. At the conditions of partial pressure =5x10-2Pa, it is WO3 by the vacuum deposition method. It formed by the 1000nm thickness.

[0045] Next, as a layer [6th] transparent-electrode layer (transparent electric conduction layer), on condition that substrate temperature =300 degree C, O2 partial-pressure =5x10-2Pa, and RF power =150W, ITO was formed by the 300nm thickness by the RF ion-plating method, and the electrochromic stratum functionale of six layer structures was formed.

[0046] Moreover, the acid-resisting layer containing an exoergic layer was formed on transparent glass-substrate B. Specifically They are ITO transparency heating element layer:1.9 and aluminum2 O3 from a substrate side about refractive-index:1.70 of the transparent glass substrate to light with a main wavelength of 540nm, and the refractive index of each class. : 1.6, ZrO2 : 2.1, aluminum2 O3 : 1.6, ZrO2 : 2.1 and MgF2 : Each optical thickness was formed with vacuum deposition by 1.38 as 90nm, 20nm, 159nm, 23nm, 66nm, and 135nm.

[0047] The resin seal of the pure side of substrate B was carried out and carried out inside the electrochromic stratum-functionale side of substrate A obtained as mentioned above, and the electrochromic element was constituted.

[0048] When the tinction speed from which the current of 0.5A is supplied to ITO heating element layer by the side of substrate B of this electrochromic element on the voltage of direct-current 5V, the voltage of **2V is impressed between both the transparent electric conduction layers of the electrochromic stratum functionale by the side of substrate A, and the contrast ratio of mean permeability with a wavelength of 400-700nm becomes ten or more was measured in the 40 degrees C - -20 degrees C environment, it was 20 or less msec in any environment.

[0049] [Example 4] The transparent heating element layer and the acid-resisting layer were first formed on the transparent glass substrate. Specifically They are ITO transparency heating element layer:1.9 and aluminum2 O3 from a substrate side about refractive-index:1.70 of the transparent glass substrate to light with a main wavelength of 540nm, and the refractive index of each class. : 1.6, ZrO2 : 2.1, aluminum2 O3 : 1.6, ZrO2 : 2.1 and MgF2 : Each optical thickness was formed with vacuum deposition by 1.38 as 90nm, 20nm, 159nm; 23nm, 66nm, and 135nm.

[0050] Next, the field in which the above-mentioned transparent heating element layer and acid-resisting layer of a transparent glass substrate were formed is substrate temperature =300 degree C and O2 as a layer [1st] transparent-electrode layer (transparent electric conduction layer) on the field of an opposite side. On condition that partial pressure =5x10-2Pa, ITO was formed by the 150nm thickness by the vacuum deposition method.

[0051] Next, it is a substrate temperature = room temperature and O2 as an oxidization coloring nature electrochromic layer of the 2nd layer. Ir oxide was formed by the 5nm thickness by the RF spatter which used the metal Ir as the target on partial pressure =1Pa conditions.

[0052] Next, it is Ir(water) oxide and SnO2 by the 2 yuan RF spatter using the metal Ir target and the metal Sn target as a mixolimnion of the 3rd layer at a substrate temperature = room temperature and steam partial pressure =1Pa conditions. The mixolimnion was formed by the 25nm thickness.

[0053] Next, it is substrate temperature =300 degree C and O2 as a layer [4th] transparent ion electric conduction layer. At the conditions of partial pressure =3x10-2Pa, it is Ta2 O5 by the vacuum deposition method. It formed by the 300nm thickness.

[0054] Next, it is substrate temperature =300 degree C and O2 as a reduction coloring nature electrochromic layer of the 5th layer. At the conditions of partial pressure =5x10-2Pa, it is WO3 by the vacuum deposition method. It formed by the 1000nm thickness.

[0055] Next, as a layer [6th] transparent-electrode layer (transparent electric conduction layer), on condition that substrate temperature =300 degree C, O2 partial-pressure =5x10-2Pa, and RF power =150W, ITO was formed by the 300nm thickness by the RF ion-plating method, and the electrochromic stratum functionale of six layer structures was formed.

[0056] The resin seal of the electrochromic stratum functionale of the substrate of the drawing 1 obtained as mentioned above was carried out, and the electrochromic element was constituted.

[0057] When the tinction speed from which the current of 0.5A is supplied to ITO heating element layer by the side of the acid-resisting layer of this electrochromic element on the voltage of direct-current 5V, the voltage of **2V is impressed between both the transparent electric conduction layers of the electrochromic stratum functionale, and the contrast ratio of mean permeability with a wavelength of 400-700nm becomes ten or more was measured in the 40 degrees C - -20 degrees C environment, it was 20 or less msec in any environment.

[0058] Except having not formed a transparent heating element layer and an acid-resisting layer on both the transparent glass substrate that constitutes the [example 1 of comparison] electrochromic element, when an electrochromic element was constituted like an example 1 and a tinction speed was measured in a 40 degrees C - -20 degrees C environment, it is set to 20 or more msec below 10 degrees C, and stopped coloring uniformly below 0 degree C.

[0059]

[Effect of the Invention] According to [as explained above] this invention, it is WO3. The remarkable improvement of a tinction property in low temperature was attained by adding a heating element layer to the electrochromic element using a reduction coloring nature electrochromic layer like a grade.

[0060] Moreover, in the penetrated type electrochromic element, the remarkable improvement of a tinction property in low temperature was attained a transparent heating element layer and by adding an acid-resisting layer further, without causing a fall of an optical property.

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Patent Abstracts of Japan

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 INVENTOR : TERADA JUNJI;
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 TITLE : ELECTROCHROMIC ELEMENT

透明導電層 (ITO)	✓
還元発色性エレクトロクロミック層 (WO ₃)	✓
透明イオン導電層 (Ta ₂ O ₅)	✓
Ir (水) 酸化物とSnO ₂ の混合層	
酸化発色性エレクトロクロミック層 (Ir (水) 酸化物)	✓
透明導電層 (ITO)	✓

透明ガラス基板	glass ?
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ITO
Al ₂ O ₃
ZrO ₃
Al ₂ O ₃
ZrO ₃
MgF ₂

ABSTRACT : PURPOSE: To improve coloring characteristics of an electrochromic element (coloring rate and contrast ratio of coloring and decolor) in a low temp. environment.

CONSTITUTION: This element has such a structure that an electrochromic functional layer including a reductive color developing electrochromic layer and a transparent ion conductive layer, and an antireflection layer including a transparent heat generating layer of ITO are held between a pair of transparent conductive layers and that these layers are held between transparent glass substrates.

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1/1 - (C) WPI / DERWENT
AN - 96-489278 §49!
AP - JP950074729 950308
PR - JP950074729 950308
TI - Electrochromic component e.g. variable filter - has heat emission layer of reflection prevention layer, which is made of indium tin oxide and formed on both sides of transparent glass substrate
IW - ELECTROCHROMIC COMPONENT VARIABLE FILTER HEAT EMIT LAYER REFLECT PREVENT LAYER MADE INDIUM TIN OXIDE FORMING SIDE TRANSPARENT GLASS SUBSTRATE
PA - (CANON) CANON KK
PN - JP8248451 A 960927 DW9649 G02F1/153 005pp
ORD - 1996-09-27
IC - G02F1/153
FS - GMPI;EPI
DC - P81 U14 V07
AB - J08248451 The component includes an electrochromic layer which has colour redn. and development characteristic, and a transparent-ion electric conduction layer provided between two electrode layers.
- A reflection prevention layer contains a heat emission layer which is made of indium tin oxide, and formed on both sides of a transparent glass substrate.
- ADVANTAGE - Improves colouring characteristic in low temp. without reducing optical characteristic, by adding transparent heat emission layer and reflective prevention layer.(Dwg.1/1)

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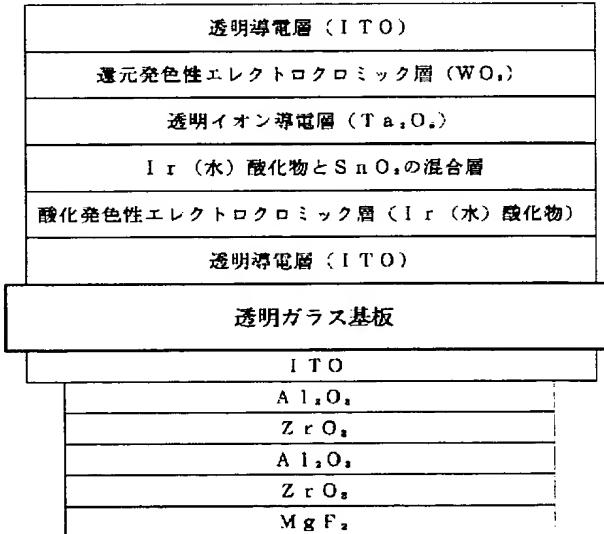
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(54)【発明の名称】 エレクトロクロミック素子

(57)【要約】

【目的】 エレクトロクロミック素子の低温環境での着色特性(着色速度、着消色のコントラスト比)を改善する。

【構成】 一対の透明導電層の間に還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層と、ITOからなる透明発熱体層を含む反射防止層が、透明ガラス基板を挟んで形成された構成を有することを特徴とする。



【特許請求の範囲】

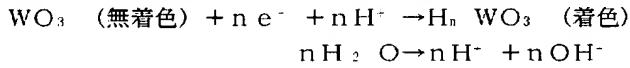
【請求項1】 一対の電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層と、発熱体層が、基板を挟んで形成された構成を有することを特徴とするエレクトロクロミック素子。

【請求項2】 一対の電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層が形成された基板Aと、発熱体層が形成された基板Bを、前記エレクトロクロミック機能層と前記発熱体層を内側にして、若しくは前記エレクトロクロミック機能層を内側に前記発熱体層を外側にして対向配置した構成を有することを特徴とするエレクトロクロミック素子。

【請求項3】 一対の透明電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層と、透明発熱体層が、透明基板を挟んで形成された構成を有することを特徴とするエレクトロクロミック素子。

【請求項4】 前記透明発熱体層の上に、更に反射防止層が形成されていることを特徴とする請求項3に記載のエレクトロクロミック素子。

【請求項5】 一対の透明電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層が形成された透明基板Aと、透明発熱体層が形成された透明基板Bを、前記エレクトロクロミック機能層と前記透明発熱体層を内側にして、若しくは前記エレクトロクロミック機能層を内側*



という反応が推定されている。

【0005】

【発明が解決しようとする課題】 しかしながら、前述した様に WO_3 の着色には水が必要不可欠であるため、EC素子を例えばスキー場の様な氷点下で使用した場合、着色しなかったり、着色速度が遅くなるという問題点があった。

【0006】 また、EC素子の低温環境での着色速度の改善としては、特開昭61-59317号公報で提案されているが、これは着色と発熱を同一の導電膜で行っているため、回路が複雑になったり、発熱だけのために電圧を高くできないという問題点があった。

【0007】 従って、本発明の目的は、EC素子の低温環境での着色特性（着色速度、着消色のコントラスト比）を簡単な構造で改善することにある。

【0008】

【課題を解決するための手段及び作用】 上記目的を達成するための本発明の構成は以下の通りである。

【0009】 即ち、本発明の第一は、一対の電極層の間に少なくとも還元発色性エレクトロクロミック層と透明

*に前記透明発熱体層を外側にして対向配置した構成を有することを特徴とするエレクトロクロミック素子。

【請求項6】 前記透明基板Aの外側の面と、前記透明基板Bの外側の面に、反射防止層が形成されていることを特徴とする請求項5に記載のエレクトロクロミック素子。

【請求項7】 前記透明電極層がITO (SnO₂ 含有 In_2O_3)、前記還元発色性エレクトロクロミック層が WO_3 、前記透明発熱体層がシート抵抗値 $10\ \Omega/\square$ 以上のITOであることを特徴とする請求項3～6のいずれかに記載のエレクトロクロミック素子。

【発明の詳細な説明】

【0001】

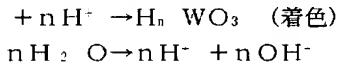
【産業上の利用分野】 本発明は、表示素子や透過率可変フィルターとして応用されるエレクトロクロミック素子に関する。

【0002】

【従来の技術】 電圧を印加することにより着消色するエレクトロクロミック（以下、「EC」と記す）素子は、液晶素子等と比較して、消色時の透過率が高い、偏光の影響を受けない、メモリー性があるといった特徴があるため、表示素子や透過率可変フィルター等への応用について研究されている。

【0003】 その一つとして、還元発色性エレクトロクロミック層に WO_3 を用いたEC素子が、特公昭52-46098号において提案されている。

【0004】 この WO_3 が着色するには、水が電場中で分解した H^- カチオンが必要で、着色時には、



イオン導電層を有するエレクトロクロミック機能層と、発熱体層が、基板を挟んで形成された構成を有することを特徴とするエレクトロクロミック素子にある。

【0010】 本発明の第二は、一対の電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層と、透明発熱体層が、透明基板を挟んで形成された構成を有することを特徴とするエレクトロクロミック素子にある。

【0011】 本発明の第三は、一対の透明電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層と、透明発熱体層が、透明基板を挟んで形成された構成を有することを特徴とするエレクトロクロミック素子にある。

【0012】 本発明の第四は、一対の透明電極層の間に少なくとも還元発色性エレクトロクロミック層と透明イオン導電層を有するエレクトロクロミック機能層が形成された透明基板Aと、透明発熱体層が形成された透明基

板Bを、前記エレクトロクロミック機能層と前記透明発熱体層を内側にして、若しくは前記エレクトロクロミック機能層を内側に前記透明発熱体層を外側にして対向配置した構成を有することを特徴とするエレクトロクロミック素子にある。

【0013】本発明のエレクトロクロミック素子は、発熱体層に電圧を印加することでこれを発熱させることにより、氷点下の環境で使用する場合においても良好な着色特性を示すものである。

【0014】前記本発明の第三及び第四は、特に透過型のエレクトロクロミック素子に係るものであり、本発明第三では前記透明発熱体層の上に更に反射防止層が形成されていることが望ましく、本発明第四では前記透明基板Aの外側の面と、前記透明基板Bの外側の面に、反射防止層が形成されていることが望ましい。これにより、透過型エレクトロクロミック素子の光学特性を向上することができる。

【0015】本発明の第三及び第四に係る透明電極層としては、例えばITO(SnO₂含有In₂O₃)、In₂O₃、SnO₂等を用いることができるが、光学特性や抵抗値の面でITO(重量比In₂O₃/SnO₂≈95/5)が望ましい。

【0016】還元発色性エレクトロクロミック層としては、例えばWO₃、MoO₃、Nb₂O₅、TiO₂等を用いることができるが、着色速度の面でWO₃が望ましい。

【0017】透明発熱体層としては、例えばITOを用いることができ、そのシート抵抗値は10Ω/□以上であることが望ましい。透明発熱体層のシート抵抗値が10Ω/□よりも小さいと、十分発熱しなかったり、消費電力が大きくなるといった問題が生じ易い。

【0018】上記各層の成膜法としては、公知の成膜法を用いることができ、例えば真空蒸着、スパッタ、イオンプレーティング、CVD等が用いられる。また、各層の膜厚は1nmから5000nmが望ましく、要求される光学特性、繰り返し耐久性等により適宜設計される。

【0019】

【実施例】以下に実施例を示し、本発明を詳細に説明する。

【0020】【実施例1】図1は本実施例のエレクトロクロミック素子を構成する一方の基板の模式的構成図であり、以下にその製造プロセスを説明する。

【0021】先ず、透明ガラス基板上に透明発熱体層及び反射防止層を形成した。具体的には、中心波長540nmの光に対する透明ガラス基板の屈折率：1.70、各層の屈折率を基板側からITO透明発熱体層：1.9、Al₂O₃：1.6、ZrO₂：2.1、Al₂O₃：1.6、ZrO₂：2.1、MgF₂：1.38で各々の光学的膜厚を90nm、20nm、159nm、23nm、66nm、135nmとして真空蒸着で成膜

した。

【0022】次に、透明ガラス基板の上記透明発熱体層及び反射防止層を形成した面とは反対側の面上に、第1層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりITOを150nmの膜厚で形成した。

【0023】次に、第2層の酸化発色性エレクトロクロミック層として、基板温度=室温、O₂分圧=1Paの条件で、金属Irをターゲットとした高周波スパッタ法によりIr酸化物を5nmの膜厚で形成した。

【0024】次に、第3層の混合層として、基板温度=室温、水蒸気分圧=1Paの条件で、金属Irターゲットと金属Snターゲットを用いた2元高周波スパッタ法により、Ir(水)酸化物とSnO₂の混合層を25nmの膜厚で形成した。

【0025】次に、第4層の透明イオン導電層として、基板温度=300℃、O₂分圧=3×10⁻²Paの条件で、真空蒸着法によりTa₂O₅を300nmの膜厚で形成した。

【0026】次に、第5層の還元発色性エレクトロクロミック層として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりWO₃を100nmの膜厚で形成した。

【0027】次に、第6層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Pa、高周波パワー=150Wの条件で、高周波イオンプレーティング法によりITOを300nmの膜厚で形成して、6層構造のエレクトロクロミック機能層を形成した。

【0028】上記の様にして得られた図1の基板のエレクトロクロミック機能層側と、別途反射防止層を片面に形成した透明ガラス基板の無垢側の面を内側にして樹脂封止し、エレクトロクロミック素子を構成した。

【0029】このエレクトロクロミック素子の透明発熱体層に直流5Vの電圧で0.5Aの電流を供給し、エレクトロクロミック機能層の両透明導電層間に±2Vの電圧を印加して、波長400~700nmでの平均透過率のコントラスト比が1.0以上になる着色速度を40℃~-20℃の環境で測定したところ、いずれの環境でも20ms以下であった。

【0030】【実施例2】透明ガラス基板A上に最初に、反射防止層を形成した。

【0031】次に、反射防止層を形成した面とは反対側の面上に、第1層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりITOを150nmの膜厚で形成した。

【0032】次に、第2層の酸化発色性エレクトロクロミック層として、基板温度=室温、O₂分圧=1Paの条件で、金属Irをターゲットとした高周波スパッタ法

によりIr酸化物を5nmの膜厚で形成した。

【0033】次に、第3層の混合層として、基板温度=室温、水蒸気分圧=1Paの条件で、金属Irターゲットと金属Snターゲットを用いた2元高周波スパッタ法により、Ir(水)酸化物とSnO₂の混合層を25nmの膜厚で形成した。

【0034】次に、第4層の透明イオン導電層として、基板温度=300℃、O₂分圧=3×10⁻²Paの条件で、真空蒸着法によりTa₂O₅を300nmの膜厚で形成した。

【0035】次に、第5層の還元発色性エレクトロクロミック層として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりWO₃を100nmの膜厚で形成した。

【0036】次に、第6層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Pa、高周波パワー=150Wの条件で、高周波イオンプレーティング法によりITOを300nmの膜厚で形成して、6層構造のエレクトロクロミック機能層を形成した。

【0037】上記の様にして得られた基板Aのエレクトロクロミック機能層側と、別途片面に反射防止層、反対面にITOの透明発熱体層を形成した透明基板Bの透明発熱体層側を内側にして樹脂封止し、エレクトロクロミック素子を構成した。

【0038】このエレクトロクロミック素子の透明基板B側のITO発熱体層には直流5Vの電圧で0.5Aの電流を供給し、基板A側のエレクトロクロミック機能層の両透明導電層間に±2Vの電圧を印加して、波長400~700nmでの平均透過率のコントラスト比が1.0以上になる着色速度を40℃~-20℃の環境で測定したところ、いずれの環境でも20ms以下であった。

【0039】【実施例3】透明ガラス基板A上に最初に、反射防止層を形成した。

【0040】次に、反射防止層を形成した面とは反対側の面上に、第1層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりITOを150nmの膜厚で形成した。

【0041】次に、第2層の酸化発色性エレクトロクロミック層として、基板温度=室温、O₂分圧=1Paの条件で、金属Irをターゲットとした高周波スパッタ法によりIr酸化物を5nmの膜厚で形成した。

【0042】次に、第3層の混合層として、基板温度=室温、水蒸気分圧=1Paの条件で、金属Irターゲットと金属Snターゲットを用いた2元高周波スパッタ法により、Ir(水)酸化物とSnO₂の混合層を25nmの膜厚で形成した。

【0043】次に、第4層の透明イオン導電層として、

基板温度=300℃、O₂分圧=3×10⁻²Paの条件下、真空蒸着法によりTa₂O₅を300nmの膜厚で形成した。

【0044】次に、第5層の還元発色性エレクトロクロミック層として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりWO₃を100nmの膜厚で形成した。

【0045】次に、第6層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Pa、高周波パワー=150Wの条件で、高周波イオンプレーティング法によりITOを300nmの膜厚で形成して、6層構造のエレクトロクロミック機能層を形成した。

【0046】また、透明ガラス基板B上に、発熱層を含む反射防止層を形成した。具体的には、中心波長540nmの光に対する透明ガラス基板の屈折率:1.70、各層の屈折率を基板側からITO透明発熱体層:1.9、Al₂O₃:1.6、ZrO₂:2.1、Al₂O₃:1.6、ZrO₂:2.1、MgF₂:1.38で各々の光学的膜厚を90nm, 20nm, 159nm, 23nm, 66nm, 135nmとして真空蒸着で成膜した。

【0047】上記の様にして得られた基板Aのエレクトロクロミック機能層側と、基板Bの無垢面を内側にして樹脂封止し、エレクトロクロミック素子を構成した。

【0048】このエレクトロクロミック素子の基板B側のITO発熱体層には直流5Vの電圧で0.5Aの電流を供給し、基板A側のエレクトロクロミック機能層の両透明導電層間に±2Vの電圧を印加して、波長400~700nmでの平均透過率のコントラスト比が1.0以上になる着色速度を40℃~-20℃の環境で測定したところ、いずれの環境でも20ms以下であった。

【0049】【実施例4】先ず、透明ガラス基板上に透明発熱体層及び反射防止層を形成した。具体的には、中心波長540nmの光に対する透明ガラス基板の屈折率:1.70、各層の屈折率を基板側からITO透明発熱体層:1.9、Al₂O₃:1.6、ZrO₂:2.1、Al₂O₃:1.6、ZrO₂:2.1、MgF₂:1.38で各々の光学的膜厚を90nm, 20nm, 159nm, 23nm, 66nm, 135nmとして真空蒸着で成膜した。

【0050】次に、透明ガラス基板の上記透明発熱体層及び反射防止層を形成した面とは反対側の面上に、第1層の透明電極層(透明導電層)として、基板温度=300℃、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりITOを150nmの膜厚で形成した。

【0051】次に、第2層の酸化発色性エレクトロクロミック層として、基板温度=室温、O₂分圧=1Paの条件で、金属Irをターゲットとした高周波スパッタ法によりIr酸化物を5nmの膜厚で形成した。

【0052】次に、第3層の混合層として、基板温度=室温、水蒸気分圧=1 Paの条件で、金属Irターゲットと金属Snターゲットを用いた2元高周波スパッタ法により、Ir(水)酸化物とSnO₂の混合層を25nmの膜厚で形成した。

【0053】次に、第4層の透明イオン導電層として、基板温度=300°C、O₂分圧=3×10⁻²Paの条件で、真空蒸着法によりTa₂O₅を300nmの膜厚で形成した。

【0054】次に、第5層の還元発色性エレクトロクロミック層として、基板温度=300°C、O₂分圧=5×10⁻²Paの条件で、真空蒸着法によりWO₃を100nmの膜厚で形成した。

【0055】次に、第6層の透明電極層(透明導電層)として、基板温度=300°C、O₂分圧=5×10⁻²Pa、高周波パワー=150Wの条件で、高周波イオンプレーティング法によりITOを300nmの膜厚で形成して、6層構造のエレクトロクロミック機能層を形成した。

【0056】上記の様にして得られた図1の基板のエレクトロクロミック機能層を樹脂封止して、エレクトロクロミック素子を構成した。

【0057】このエレクトロクロミック素子の反射防止層側のITO発熱体層に直流5Vの電圧で0.5Aの電流を供給し、エレクトロクロミック機能層の両透明導電

層間に±2Vの電圧を印加して、波長400~700nmでの平均透過率のコントラスト比が10以上になる着色速度を40°C~-20°Cの環境で測定したところ、いずれの環境でも20ms以下であった。

【0058】[比較例1]エレクトロクロミック素子を構成する両透明ガラス基板上に透明発熱体層及び反射防止層を成膜しなかったこと以外は、実施例1と同様にしてエレクトロクロミック素子を構成し、40°C~-20°Cの環境で着色速度を測定したところ、10°C以下で20ms以上となり、0°C以下では均一に着色しなくなった。

【0059】

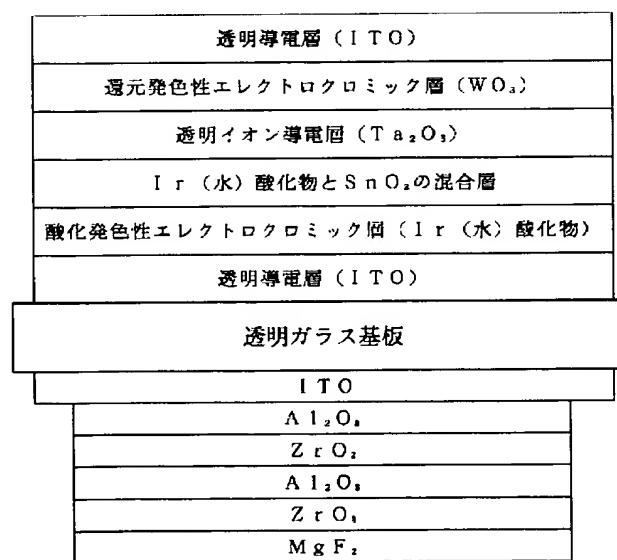
【発明の効果】以上説明したように、本発明によれば、WO₃等のような還元発色性エレクトロクロミック層を用いたエレクトロクロミック素子に、発熱体層を付加することにより、低温における着色特性の著しい改善が可能となった。

【0060】また、透過型エレクトロクロミック素子においては、透明発熱体層、更には反射防止層を付加することにより、光学特性の低下を招くことなく低温における着色特性の著しい改善が可能となった。

【図面の簡単な説明】

【図1】実施例1のエレクトロクロミック素子を構成する一方の基板の模試的構成図である。

【図1】



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